

SECTION 400.00 – GUIDELINES FOR INVESTIGATIONS

A foundation, retaining wall, or highway cannot be properly designed unless the designer has the engineering properties of the materials involved well in mind. The essential information is developed in a soil investigation, which includes field exploration, laboratory testing, engineering analysis, and a written report.

The scope of the exploration and testing program must consider the initial cost, the risk associated with the size and complexity of the project, and the anticipated soil conditions. A lack of accurate information must be compensated by the use of a liberal factor of safety in design.

The cost of a thorough subsurface investigation for a large project is usually small compared to the savings that can be realized by utilizing the results in design and construction, or when compared to the costs associated with a failure due to erroneous design assumptions.

No matter how complete the program of exploration and testing, there always remains an element of uncertainty concerning the exact nature of subsurface conditions. Soil tests performed on a few samples, unlike tests on other structural materials, do not necessarily provide a satisfactory basis for design because: (1) the samples tested may not represent the critical materials or condition, and (2) the engineer is concerned about the behavior of the deposit as a whole rather than the action of individual samples.

The importance of a close relationship of the investigating personnel (Geologist, Materials Engineer, and Geotechnical Engineer) with design and construction personnel cannot be overemphasized. This relationship is necessary to ensure that recommendations are correctly interpreted and recognized in design. Also, as construction exposes subsurface conditions that appear to be problem areas and/or different from conditions reflected in design, materials and design personnel should be consulted before changes in design are made.

SECTION 410.00 – FOUNDATIONS

This section provides guidelines for planning and conducting investigations for structures.

410.01 Bridge Survey Records. Prepare Forms ITD-209, Computations for Scour Around Piers, and [ITD-210](#), Hydraulic Structures Survey, for all requests for the design of culverts or bridges crossing live or intermittent stream courses, canals, or water.

Some questions do not apply to all structures and may be difficult to answer accurately. However, any information that can be given will aid the Materials and Bridge Sections. These are:

- Type of structure recommended.
- Highest permissible elevation of bottom of footings.
- Length of piling.
- Character of foundation materials.

The main purpose of requesting the type of structure is to take care of those structures that cross streams where it is necessary to have approval of others. This is true of all structures where irrigation laterals, canals, and live streams are involved. In many cases, several types of structures could be used, but if the canal company, Department of Fish and Game, or Corps of Engineers will not permit piers in the stream and insist on a clear span, the number of types are greatly reduced.

The question of the elevation of the bottom of footings is to make sure the field personnel has studied the possibility of scour of the streambed and to make sure the footings of the structure are set deep enough to prevent a failure of the structure by the footings being undermined. A study of the streambed and the contour map will aid in answering this question.

The question on length of piling cannot be answered if the structure is in a new location. However, if the proposed structure is a replacement of an existing structure, the existing pile penetration data would aid the Bridge Section. This information is in our files on structures built by the Idaho Transportation Department and a reference to the structure is all that is required. In the final analysis, this question will be answered by the foundation investigation and test piles.

The question on the character of the foundation materials is very important as it affects the choice of exploration equipment. See Idaho T-23, "Standard Method of Foundation Investigation," to select proper exploration equipment.

410.02 Request for Investigation. The District Project Development Section furnishes the Bridge Section with a topographic map of the site together with profile grades and alignments of the finished roadway approaches. Also, Forms ITD-209 and/or [ITD-210](#) are submitted to the Bridge Section at this time for structures over drainages and channels.

In some instances, the District Materials Section may put one or two borings at selected locations at the time they are conducting their soil investigation, preferably at each end of the proposed structure. The logs of these borings and their interpretation are sent to the Materials Section as a preliminary report, where they will be reviewed and sent to the Bridge Supervisor with applicable comments.

After the Bridge Section has selected the type and size of the structure, the Bridge Supervisor will send copies of Forms ITD-209 and/or [ITD-210](#), when available, along with the topographic map showing pier and abutment locations and recommended borings to the Geotechnical Engineer and to the District Materials Section. Approximate dead and dead plus live loads will be included in the request for investigation. The District Materials Engineer and the Geotechnical Engineer will confirm or alter recommended borings based on their knowledge of the site and set up an exploration program.

410.03 Planning the Exploration. The District Materials Engineer and/or District Geologist will make a reconnaissance of the site to determine the type of investigation required, equipment needed, sampling or field testing procedure, etc. In areas of known uniform subsoil conditions, this may not be necessary. Property ownership must be determined and written permission for right of entry and investigation must be obtained using form ITD-363, Right-of-Way Contract. Arrangements for paying damage are covered in the Right-of-Way Contract. In conducting the investigations, use "Standard Method of Foundation Investigation," Idaho T-23, as a guide in obtaining the desired information.

SECTION 420.00 – GUIDELINES FOR EXPLORATION

420.01 General. A direct examination of subsurface conditions must be made by means of borings and/or test pits. Borings and test pits must be referenced to centerline stations with offset distances and must show elevations referenced to a datum. Representative disturbed samples must be taken for classification tests and determination of amount of water present. Undisturbed samples are taken if the structure foundation properties are to be determined by laboratory tests. The groundwater level, if it exists, must be identified.

The following sections present guidelines regarding the number and depth of borings or test pits typically needed to develop an adequate picture of the subsurface conditions.

Where subsurface conditions are indicated by visible features, or from previous explorations, an abbreviated exploration program may be appropriate; however, borings and/or test pits will still be needed to confirm the visible evidence.

420.02 Bridge Structures. Bridges will typically be supported on materials at least one meter (three feet) below the lowest adjacent grade, stream bottom, or scour elevation. Although the economics vary between bridges, spread footings will not commonly be bottomed deeper than about 5 meters (15 feet) below adjacent grade.

At least one boring is typically required per substructure unit (abutment or pier). On bridges more than 30 meters (100 feet) wide, where foundation conditions are variable, or on rock foundations, additional borings are necessary. On multiple short-span bridges, particularly on uniform subsurface conditions, borings at each substructure unit are not usually needed. Where appropriate in obtaining the needed information, Dutch Cone (CPT) or driven cone point penetrometer can be used to reduce the number of borings.

Advance borings through any soils unsuitable for support and into competent material. Borings should extend to a depth of at least five times the anticipated footing width; or deeper than anticipated pile penetration. One or more borings should penetrate deeply enough below the probable pile penetration to define any compressible material within the zone of influence of the piles (typically two to three times the least pile group dimension). Advance borings 1.5 to 3 meters (5 to 10 feet) into rock if encountered at shallower depths. Approximate abutment and pier loads, supplied by the Bridge Section, may be used to estimate footing width or pile group size, which will aid in determining boring depths.

420.03 Buildings. The number of borings and/or test pits needed to adequately explore a building site will depend on the size and shape of the building and the variability of the subsurface conditions. No hard and fast rules are proposed, but the number of borings should be adequate to define the subsurface profile and provide samples of the various strata for laboratory analysis.

However, as a general guide, drill at least two borings for buildings up to about 200 m² (2,150 s.f.); a single boring may be adequate if a building is very small. Drill at least one additional boring for each 200 m² (2,000 s.f.) additional floor space up to about 1000 m² (11,000 s.f.).

For larger buildings, drill an additional boring for each additional 500 to 1,000 m² (5,500 to 11,000 s.f.). These guidelines presume relatively uniform site conditions and building loads.

Additional borings should be drilled at locations of concentrated heavy loads. If the building footprint is unusually shaped, there are stringent differential settlement requirements where the subsurface conditions are erratic or change rapidly and if the site has been previously filled. Additional borings may be needed along utility corridors, particularly sewer lines.

Backhoe excavated test pits may suffice for very lightly loaded buildings where competent soils (sand, gravel, or rock) are shallow. However, borings are recommended to define the soil profile with the least disturbance and to obtain undisturbed samples.

Most buildings constructed by ITD are supported on shallow spread footings; notable exceptions are the District 2 office addition and EOC and the District 5 EOC, which are supported on drilled piers and piles because of high potential settlement in the thick surface silt layers. Typical maintenance building column loads are in the order of 90 to 130 kN (10 to 15 tons). These loads can be used to estimate footing widths and, therefore, aid in estimating minimum boring depths. Approximate loads for unusual building or foundation configurations should be requested from the Maintenance Section.

Drill borings to depth below the probable footing elevation equal to at least five times the approximate footing width. If rock or dense gravel strata are encountered at shallower depths, borings should extend 1.5 to 3 meters (5 to 10 feet) into the dense material. All borings should penetrate below the depth of excavation, regardless of the type of material, and borings should extend through any loose, soft, or otherwise unsuitable soil layers.

420.04 Retaining Walls. Borings for retaining walls should be spaced 30 to 60 meters (100 to 200 feet) apart on uniform sites. Some borings may be needed in front of and behind wall locations to define the subsurface conditions perpendicular to the wall.

Extend borings to a depth equal to at least twice the height of the wall and/or three to five times the probable footing width. For pile foundations, use the guidelines presented above in [Section 420.02](#) for bridge structures.

For mechanically stabilized embankments (such as reinforced earth), follow guidelines for embankments presented in [Section 430.00](#), Cuts and Embankments. Where rock or dense gravels are encountered at shallow depth, extend borings 1.5 to 3 meters (5 to 10 feet) into rock and 3 to 5 meters (10 to 15 feet) into gravel.

420.05 Drainage Structures. This section is intended for culverts, arches, bottomless arches supported on footings, box culverts, etc., which may be used as drainage structures or machine and stock passes. Exploration for most culverts will be accomplished in conjunction with the embankment as described in [Section 430.02](#). Specific foundation exploration for the culvert is needed where foundation conditions will require treatment and removal or where significant settlement is anticipated. Exploration for bottomless arches ("superspan," etc.) and box culverts is needed to define support conditions of the footings and bottom slabs.

Drill at least two borings for footing supported structures and box culverts. Drill additional borings at about 30 to 60 meter (100 to 200 foot) centers on long structures. More closely spaced borings may be needed to profile the surfaces of possible bearing layers such as rock or dense gravel.

The depth of footings will be dictated by scour potential as well as foundation conditions. Drill borings to depths equal to at least three to five times the footing width or two times the structure width for box culverts. For high fills or on compressible soils, the weight of the fill may require deeper borings, as the fill weight controls the settlement. If rock is encountered at shallow depths

(within the zone of influence of the fill), extend at least two borings 1.5 to 3 meters (5 to 10 feet) into rock.

420.06 Sampling and Field Testing. Sampling of materials encountered in foundation exploration is performed in several ways; i.e., bag samples from auger borings or test pits, cuttings from rotary borings, standard penetration test samples, split barrel ring samples, thin-wall Shelby tubes, or coring. Each is suited to particular materials or a specific purpose. Undisturbed samples suitable for laboratory consolidation and strength tests are primarily recovered from fine grained soils (silts and clays) using thin-wall Shelby tubes. The split barrel ring sampler provides lower quality samples, but may be used to obtain adequate samples for strength testing in sands, silts, and nonsensitive clays. Samples of sandy soils for consolidation testing are usually obtained using the ring sampler. Hard or cemented soils and rock are typically sampled using a pitcher barrel or diamond core.

Standard penetration tests and ring samples are typically taken at 1 meter (5-foot) intervals or at changes in materials. Shelby tubes are taken in soft or sensitive soils where consolidation and strength data are needed. Testable samples are typically concentrated in the depth interval between zero and three times the width of the footing. A well-defined, full-depth profile is needed for both pile foundations and embankment exploration.

Field tests are performed to provide in situ strength data, water levels, and estimates of permeability. They also reduce the number of borings needed or rapidly explore conditions between borings. Standard penetration tests, field vane shear, and Dutch Cone are the primary methods available to develop in situ strength data. Iowa bore hole shear and pressure meter equipment can be obtained or contracted in special cases. The Dutch Cone, point penetrometer, and geophysical methods such as seismic refraction and resistivity are the primary field tests available for extending information between borings.

The Dutch Cone is the preferred method for obtaining in-place strength data in sands and silts. Standard penetration tests will often underestimate the relative density of sands and silts below the water table due to heaving of soil into the auger stem or casing.

Full scale or modeled footing load tests or plate bearing tests can be used in special cases to measure bearing capacity and deformation directly. On modeled footing or plate bearing tests, the zone of influence of the footing or plate may not extend into deeper, weak materials if they exist.

The following tables indicate the usual applications for available sampling and field testing methods. Standard Test Methods and references relating to exploration, sampling, and field testing are listed in [Section 450.00](#), References.

420.06.01 Summary of Sampling Methods.

Sample Type	Applicable Tests	Appropriate Soil Type
Bulk or Bag	Classification, pavement design compaction Remolded strength and consolidation	All Sands, silts, clays
Cuttings	Visual description	All
Standard Penetration	Classification, moisture	All
Ring Sample*	Classification, moisture, density, strength and consolidation**	All except gravels
Shelby Tube	Classification, moisture, density, strength and consolidation	Fine-grained soils, silts and clays
Pitcher or Soils Core Barrel	Classification, moisture, density, strength	Hard or cemented silts and clays, soft rock
Diamond Core	Density, strength, mineralogy	Rock and some hard or cemented soils

*May be driven like a standard penetration test in dense or stiff soils.

**Primarily in sandy soils. Also satisfactory for strength tests in nonsensitive and very stiff clays. Not suitable in soft silts and clays or layered clays.

420.06.02 Summary of Field Tests.

Test	Properties Measured	Appropriate Soil Type
Standard Penetration	Relative density, measure of consistency in cohesive soils	All, but correlations only developed for sands
Point Penetrometer	Relative density (qualitative) approximate correlations with Standard Penetration in sands	All
Dutch Cone (CPT)	Relative density, soil stratigraphy strength	Sands, silts, clays (may be unreliable in gravels)
Field Vane	Shear strength	Clays and clayey silts
Iowa Bore Hole Shear	Shear strength	Stiff to hard fine-grained soils (boring walls must not cave or slough)
Pumping Tests	Permeability	All (granular soils may require casing)
Electrical Resistivity	Water level - soil type (local correlation with borings)	All
Seismic Refraction	Depth to rock, rock quality - or weathering	Soils underlying rock layers will not be detected
Load Tests	Bearing capacity, deformation	All

420.07 Record of Exploration. Keep a complete and systematic record of all boring, sampling, and field test data obtained for each investigation. Record the project number, the location of the site, the location and elevation of each boring and/or test pit, and the nature of the ground and the landform in the description of each site.

Construct this boring record in compliance with Idaho T-95, "Preparation of Field Logs."

420.08 Results of Investigation. The results of structure foundation investigations are presented in a Phase IV Foundation Investigation Report and Foundation Plat. The report and plat requirements are presented in [Section 250.08](#).

SECTION 430.00 – CUTS AND EMBANKMENTS

430.01 General. Investigations performed for cuts and embankments along the proposed highway alignment are performed to develop recommendations and design criteria for slope angles, embankment foundation treatments, and drainage as well as to investigate the character of the material to be excavated. For high cuts and fills, embankments on soft foundations, and side hill embankments, more than typical soils profile exploration is needed to obtain data to perform stability and settlement analysis.

430.02 Exploration Guidelines. Borings in cuts and embankment are typically spaced 60 to 150 meters (200 to 500 feet) apart, depending on the variability of subsurface conditions. In higher cuts and embankments and in side hill sections, a minimum of two borings should be located on a section perpendicular to centerline or planned slope face to establish a geologic cross section for analysis. One boring should be located near the probable catch point in cuts or near the toe in fills. Additional borings may be needed up-slope from the catch point or down-slope from the toe in areas of potential instability. Extend borings in cuts about 3 to 5 meters (10 to 15 feet) below grade or in weak soil, to firm material if deeper. Borings need not penetrate deeper than the cut height, below grade, even in weak materials.

Extend borings in fill areas into firm relatively incompressible material or to a depth of at least twice the embankment height below the existing ground if weak compressible materials persist at depth. In stable foundation materials, borings need not penetrate to a depth greater than the embankment height.

430.03 Sampling and Field Testing. Guidelines for sampling and field testing are presented in [Section 420.06](#).

Beneath embankments on soft foundations, obtain thin-walled Shelby tube samples at regular intervals to the full depth of the boring. Dutch Cone testing is valuable in delineating layer boundaries and identifying possible drainage layers which might be encountered between samples.

Where instrumentation will be needed to monitor or control excavation or embankment construction (observation wells, inclinometers, and piezometers), consider installing instruments during exploratory drilling.

430.04 Record of Exploration. Prepare record of boring, sampling, and field testing data in accordance with [Section 420.07](#) and Idaho T-95.

430.05 Results of Investigation. The results of cut and embankment investigations are usually presented in the Phase II Soils Report and Soils Profile. Special investigations for individual cuts or embankments may be presented as an addendum or supplement to the Phase II report. Supplemental reports should include boring logs, cross sections at locations of analysis, and details of special design requirements and plan views showing borings, limits of construction, and locations of special features such as drains. Requirements for the Phase II report and soils profile are presented in [Section 230.00](#).

SECTION 440.00 – LANDSLIDES

440.01 General. One of the costly problems affecting highways is landsliding. Sliding is generally a readjustment to stresses imposed by cut and fill construction, but may be due to reactivation of pre-existing slides by unusual moisture conditions. In some areas, the natural slopes are subject to periodic slide development regardless of construction activity. Slides associated with highway construction may occur during construction or remain marginally stable for years until triggered by changes in physical or environmental factors (increased precipitation, blocked drainage, slope maintenance, later construction activities, and earthquakes).

Investigation to develop preventative measures (if recognized during initial subsurface exploration) or corrective measures requires diverse methods of exploration and analysis.

Some potential or active slide masses defy theoretical approaches and, therefore, analyses rely mainly on experience and judgment, while others can be analyzed by established geotechnical methods.

440.02 Guidelines for Exploration.

440.02.01 Preliminary Reconnaissance. The District and Headquarters Materials personnel are to make a field review in order to develop an exploration program. The district will survey the area and make cross sections available to those responsible for the investigation.

If the rate of movement permits and for potential stability problems, review all available literature such as topographic maps, air photos, geologic reconnaissance reports, previous boring records, and groundwater data prior to beginning field exploration.

Where slide movement is rapid and there is a high risk to the public, corrective action and/or exploration must often be initiated based on the initial field reconnaissance and before survey and other background data is available.

440.02.02 Exploration. Examination of subsurface conditions must be made by borings and/or test pits. Reference boring or test pit locations to station, centerline, and known elevations. The primary purpose of exploration is to locate probable or actual failure zones. If this cannot be accomplished through borings, then open pits or instrumentation are needed.

Locate borings along a cross section to depict strata orientation, failure surface location, and groundwater levels. This will require at least two borings within the slide mass per cross section. The number of cross sections explored will depend on the extent and complexity of the problem. On active slides, if movement is too rapid to drill within the slide mass, locate borings above and below the active area(s).

Extend borings below potential or active failure surfaces and into stable material.

NOTE: Some failure surfaces occur below the apparent rock surface and are difficult to detect. If the failure surface is not apparent, extend borings to a depth at which geometry indicates failure is unlikely. No hard and fast rule regarding boring location or depth applies to all conditions, but little opportunity exists to return to the site of an active slide for additional information.

See Idaho T-23, "Standard Method of Foundation Investigation," for applications of various equipment to the exploration.

440.02.03 Instrumentation. In addition to recovering samples for laboratory testing, exploratory borings are used to install instrumentation for monitoring slide movement and groundwater. Inclined meters installed in exploratory borings provide information on location of the failure surface and rate of movement. When installed in potentially unstable areas prior to construction, the inclined meters are used to detect movements early enough to initiate corrective action before major failures occur. Inclined meters also function as groundwater monitoring wells.

At least two inclined meters should be installed on a cross section. Inclined meters must extend below the lowest failure surface and be socketed into firm material, if possible.

Where the failure surface is not apparent in the borings, inclinometers may be used to locate the failure surface and supplemental borings drilled to recover samples.

440.03 Sampling and Field Testing. General guidelines for sampling and field testing are presented in [Section 420.06](#).

The primary purpose in sampling borings in landslide explorations is to obtain undisturbed samples of the failure surface or zone. Depending on the character of the slide mass, ring samples, Shelby tubes, or core borings may be most appropriate. Obtain continuous samples of portions of the borings through the failure zone to assure that the material on the failure surface is recovered.

NOTE: In rotary drilling using water, failure surface material will probably be washed out of core borings and lost. Continuous ring samples or Pitcher barrel samples are more effective under these conditions.

440.04 Record of Exploration. Prepare record of boring, sampling, and field testing in accordance with [Section 420.07](#) and Idaho T-95. Indicate location of failure surface(s) on the boring logs.

440.05 Results of Investigation. Present the results of the investigation in a special report, including topographic mapping, cross sections, analysis results, boring logs, and inclinometer data. The report should address the subsurface conditions and methods and results of analysis. Recommendations for corrective action should be presented along with the comparison of alternative methods of repair.

SECTION 450.00 – REFERENCES

450.01 Idaho Standard Test Methods.

T-23	Standard Method of Foundation Investigation
T-27	Investigation of Aggregate and Borrow Deposits
T-28	Surveying and Sampling Soils for Highway Purposes
T-29	Using Electrical Resistivity Equipment for Depth Profiling
T-62	Taking of Undisturbed Samples for Laboratory Consolidation, Direct Shear and Triaxial Shear Tests
T-63	Determining the In-Place Bearing Capacity, Consistency, and Relative Denseness of Soils by Standard Penetration Method
T-64	Determining the In-Place Shearing Strength of Fine Grained Soils with the Vane Borer
T-66	Standard Method of Using the Refraction Seismic System in Subsurface Studies
T-95	Preparation of Field Logs

450.02 AASHTO Test Methods.

T 203	Soil Investigation and Sampling by Auger Borings (see also ASTM D 1452)
T 206	Penetration Test and Split Barrel Sampling of Soils (see also ASTM D 1586)
T 207	Thin-Walled Tube Sampling of Soils (see also ASTM D 1587)
T 225	Diamond Core Drilling for Site Investigation (see also ASTM D 2113)
T 223	Field Vane Shear Test in Cohesive Soils (see also ASTM D 2573)
T 235	Bearing Capacity of Soil for Static Load on Spread Footings (see also ASTM D 1194)
T 251	Soil Investigation and Sampling by Hollow-Stem Auger Borings
T 254	Installing, Monitoring, and Processing Data From the Traveling Type Slope Inclinometer

450.03 ASTM Test Methods.

D 420	Investigating and Sampling Soil and Rocks for Engineering Purposes
D 3550	Ring Lined Barrel Sampling of Soils
D 3441	Deep Quasi-Static, Cone and Friction Cone Penetration Test of Soil

450.04 Reports and Texts. The following typical references are available in the District or Headquarters Materials Section:

- "Manual on Subsurface Investigations," NCHRP Final Report 24-1, July 1984, Haley and Aldrich, Inc.
- "Checklist and Guidelines for Review of Geotechnical Reports and Preliminary Plans and Specifications," FHWA, October 1985.
- "Proceedings of a Symposium on Site Exploration in Soft Ground Using In-Situ Techniques," FHWA Report TS-80-202, May 1978.
- "Guidelines for Cone Penetration Test, Performance, and Design," FHWA Report TS-78-209, July 1978.
- "Basic Procedures for Soil Sampling and Core Drilling," W. L. Acker III, Acker Drill Co., 1974.
- "Manual on Foundation Investigations," AASHTO, 1978.
- "In-Situ Measurement of Soil Properties," ASCE, Specialty Conference, Raleigh, North Carolina, June 1975.
- "Foundation Engineering Handbook," Winterhorn and Fang, Van Nostrand-Reinhold Company, 1975.

SECTION 460.00 – REVIEW AND ACCEPTANCE PROCEDURES FOR EARTH-RETAINING SYSTEM

The purpose of these reviews and acceptance procedures are to provide: (1) a formal review and acceptance procedure for an earth-retaining system, and (2) a review procedure for use of approved retaining systems and for plans submitted by contractors/suppliers on specific projects.

460.01 Background. Since 1982, bids on alternate earth-retaining systems have been required by the Federal Highway Administration (FHWA) on federal-aid projects.

Until April 1987, FHWA provided technical assistance in reviewing the numerous proprietary earth-retaining systems available. This review responsibility now rests with the individual state transportation departments.

A formal review and acceptance procedure is necessary to minimize the potential for design and construction problems. Therefore, the Idaho Transportation Department (ITD) has developed these procedures to:

- Provide statewide uniformity.
- Establish standard policies and procedures for technical review and acceptance of earth-retaining systems.
- Establish responsibility for the acceptance of new earth-retaining systems.
- Establish standard procedures and responsibility for preparation of retaining system plans, design review, and construction control.

Approval of any new earth-retaining system will require a rigorous engineering evaluation by ITD Materials, Bridge, and Roadway Design Sections. Appropriate alternative retaining systems will be evaluated base on project-specific constraints and criteria.

460.02 General Requirements. Information from the FHWA regarding the acceptability of earth-retaining systems should be used as reference material only.

All proprietary retaining systems, bid as alternates, must have been previously approved by ITD as outlined in [Section 460.03](#).

Prefabricated or mechanically stabilized earth (MSE) retaining systems may be bid as alternates in competition with conventional reinforced concrete walls where conventional walls are competitive. However, alternatives to conventional walls are not required for all projects.

A proprietary retaining system bid without alternates must be considered experimental, unless it can be established that no other system is cost effective or technically feasible.

The same opportunity (degree of involvement) should be offered to all suppliers of proprietary earth-retaining systems which are approved and can accomplish the project objectives.

A conceptual plan approach to alternative earth-retaining systems is included in these procedures. Where conventional, nonproprietary retaining systems (cast-in-place concrete, metal bin walls, gabions, and tied-back walls) are viable alternatives, plans may be incorporated into the final contract documents.

460.03 Initial System Approval. The recent growth of many different types of earth-retaining systems requires consideration of different alternates prior to preparation of contract documents so that contractors are given an opportunity to bid using a feasible, cost-effective system. Any proprietary system must undergo ITD evaluation and be approved prior to inclusion as an alternate system during the design phase. The criteria for selection and placement on the approved list are as follows:

- A supplier or his representative requests in writing to be placed on this list.
- ITD approves the system and the supplier, based on the following considerations:
 - The supplier has a large enough operation to supply the necessary wall components and documentation on time.
 - The system has a sound theoretical and practical basis for the engineers to evaluate its claimed performance.
 - Past experience in building and performance of the proposed system.

For this purpose, the supplier or his representative must submit a package that satisfactorily addresses the following items:

- System theory and the year it was proposed.
- Where and how the theory was developed.
- Laboratory and field experiments which support the theory:
 - Practical applications with descriptions and photos.
 - Limitations and disadvantages of the system.
 - List of users including names, addresses, and telephone numbers.
 - Details of wall elements, analysis of structural elements, design calculations for both static and dynamic (earthquake) loading, factors of safety, estimated life, corrosion design procedure for soil reinforcement elements, procedures for field and laboratory evaluation including instrumentation, and special requirements, if any.
 - Sample material and construction control specifications showing material type, quality, certifications, field testing, acceptance and rejection criteria, and placement procedures.
 - A well-documented field construction manual describing in detail, with illustrations where necessary, the step-by-step construction sequence. Copies of this manual should also be provided to the contractor and the project engineer at the beginning of wall construction.
 - Typical unit costs, supported by data from actual projects.

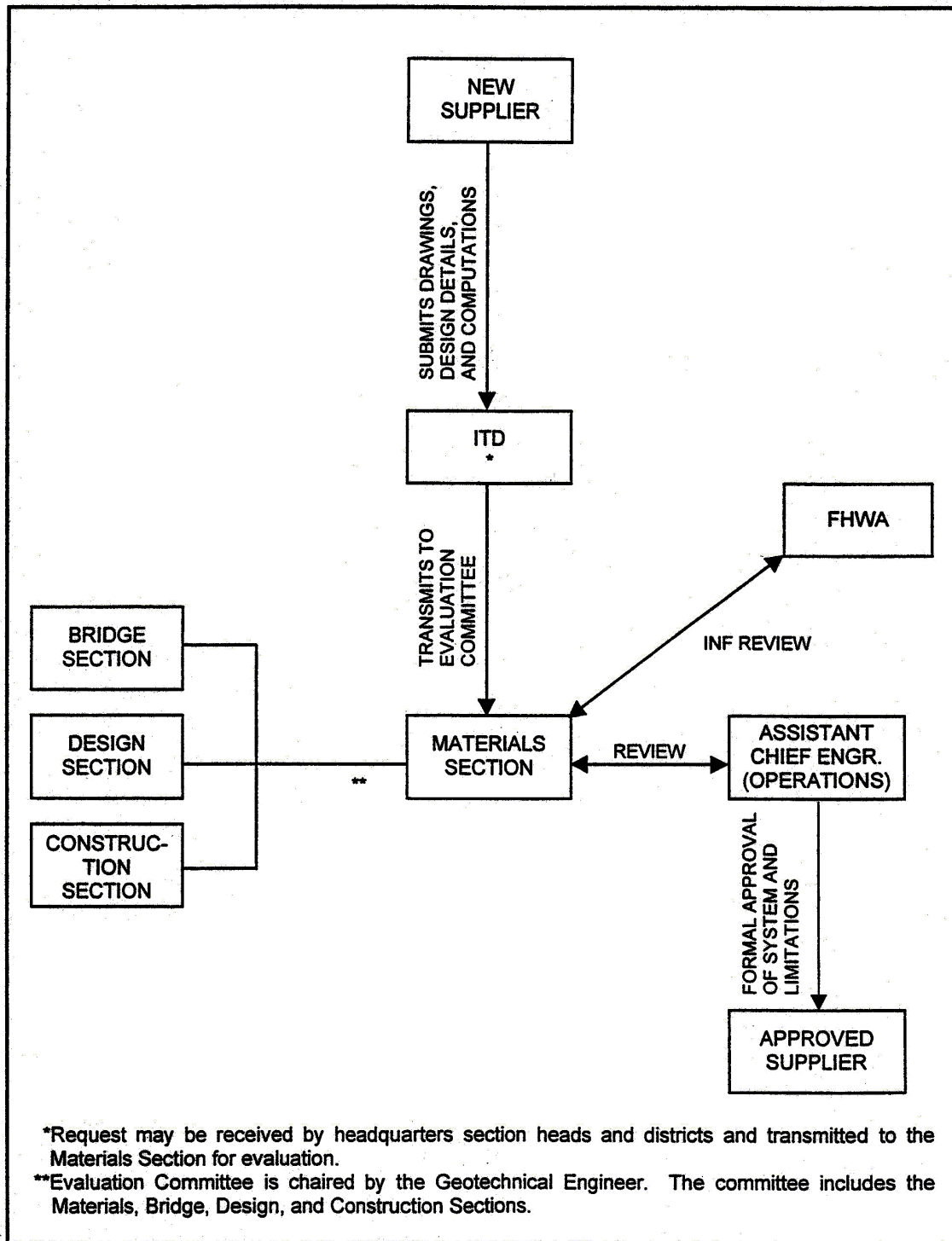


FIGURE 460.03-1. NEW EARTH RETAINING SYSTEM EVALUATION AND APPROVAL

This submittal will be given a thorough review by the ITD Earth-Retaining Systems Review Committee with regard to the design/construction practicality and anticipated performance of the system. The committee will consist of representatives of Headquarters Materials (Geotechnical), Bridge Design, Design, and Construction Sections. ITD's position on the submittal (i.e., acceptance or rejection), with technical comments and limitations, will be provided by a written notification from the Assistant Chief Engineer (Operations) after review of the committee recommendations.

Up to 1 year should be allowed for ITD review of initial supplier submittals. A flow chart indicating the sequential approval procedure is shown in [Figure 460.03-1](#). Delineation of responsibilities within ITD is outlined in [Section 460.10](#).

Systems that have been successfully constructed on ITD projects will be accepted without a complete initial submittal, but the supplier or his representative will be asked to submit the above information to see if limitations regarding height or application are appropriate.

460.04 Wall Selection Procedure. All previously approved, feasible, innovative, and cost-effective alternates must be seriously considered:

- Alternate systems during the design phase - Consultants and ITD should consider all feasible alternates and provide at least two alternates whenever possible. It is not necessary to provide for alternatives to conventional or tied-back systems if they are clearly the most feasible system.
- Experimental use - Any new system which has either previously not been used or is being used in an untried application by ITD, and/or which meets the FHWA guidelines (single alternate) as an experimental feature, will require performance documentation.
- Alternates will not be permitted on earth-retaining systems that have been designated as experimental features during a project's design phase.

460.05 Economic Considerations for Wall Selection. The decision to select a particular earth-retaining system for a specific project requires a determination of both technical feasibility and comparative economy. With respect to economy, the factors which should be considered are:

- Cut or fill earthwork situation.
- Size of wall.
- Average wall height.
- Foundation conditions (i.e., would a deep or shallow foundation be appropriate for a cast-in-place concrete retaining wall?).
- Maintenance of traffic during construction.
- Future maintenance costs.
- Aesthetics.
- Availability and cost of select backfill material.
- Cost and availability of right-of-way needed.

- Complicated horizontal and vertical alignment changes.
- Need for temporary excavation support systems.

Evaluation and selection of proposed alternative retaining system(s) will be made by the districts or consultants with assistance from the Design, Materials, and Bridge Sections, as appropriate. Design criteria for the proposed system(s) will be included in the materials phase reports. Materials investigation results may alter the feasibility of initially proposed systems. Additional or different systems and design criteria may be proposed in the phase reports.

460.06 Conceptual Plan Preparation. For the majority of projects containing proprietary earth-retaining structure alternates, ITD will use a conceptual plan approach, i.e., a fully detailed set of retaining wall plans will not be contained in the contract documents. However, when proprietary systems are allowed as alternates to a conventional reinforced concrete wall or other nonproprietary retaining structure, the detailed plans for the conventional wall may be included in the contract documents.

The conceptual plan, prepared by ITD or consultant in the bidding documents, will contain the following project-specific information:

- Geometric
 - Beginning and end of wall stations.
 - Elevation on top of wall at beginning and end of wall and all profile break points and roadway profile data at wall line.
 - Original and proposed profiles in front of and behind the retaining wall.
 - Cross sections at the retaining wall location at 15 to 30 meter (50 to 100 foot) intervals.
 - Horizontal wall alignment.
 - Details of wall appurtenances such as traffic barriers, coping, drainage outlets, location and configurations of signs, and lighting including conduit locations.
 - Right-of-way limits.
 - Construction sequence requirements, if applicable, including traffic control, access, and stage construction sequences.
 - Elevation of highest permissible level for foundation construction. Location, depth, and extent of any unsuitable material to be removed and replaced.
 - Quantities table showing estimated square meters (square feet) of wall area and quantity of appurtenances and traffic barriers.
 - At abutments, elevation of bearing pads, location of bridge seats, skew angle, and all horizontal and vertical survey control data including clearances and details of abutments.
 - At stream locations, extreme high water, and normal water levels.

- Reports
 - A copy of the Phase II Soils Report and Phase IV Foundation Investigation Report, which contain specific design criteria for the geotechnical parameters applicable to the proposed project.
- Structural and Geotechnical Design Requirements
 - Design life of the structure (e.g., permanent mechanically stabilized earth walls are commonly designed, based on corrosion, for minimum service lives of 75 years).
 - Minimum safety factors for overturning, sliding, and overall stability. (Typical values are overturning 2.0 and sliding 1.5.) AN ANALYSIS FOR OVERALL EXTERNAL SLOPE STABILITY IS PROJECT-SPECIFIC AND WILL BE PERFORMED BY ITD OR ITS CONSULTANT.
 - Allowable foundation bearing pressure, minimum wall footing embedment depth, and maximum tolerable total and differential settlements.
 - Internal design requirements for MSE system products to include allowable reinforcement materials stress, safety factor against reinforcement pullout, and allowable lateral deformation for interpretation of laboratory pullout test or in accordance with AASHTO Standard Specifications for Highway Bridges (latest version).
 - Magnitude, location, and direction of external loads due to bridges, overhead signs and lights, traffic surcharge, and rapid groundwater drawn down.
 - Limits and requirements for drainage features beneath, behind, or through the retaining structure.
 - Backfill requirements for both within and behind the retaining structure. (Both material and placement requirements should be specified, i.e., gradation, plasticity index, electrochemical, soundness, maximum loose lift thickness, minimum density, and allowable moisture content.)
 - Special facing panel and module finishes or colors.
 - Governing sections of the ITD Design Manual, Materials Manual, and [Construction Specifications](#) and Special Provisions.

The preparation of the conceptual plan is a coordinated activity among the Materials Section, the Bridge Design Section where structures are involved, and the District or Section Design. Geometric, geotechnical, and structural considerations must be complementary for the conceptual plan to convey the desired end product to the bidders.

460.07 Bidding Instructions. In order to give suppliers of proprietary walls sufficient time to prepare bids, the presence of these items in forthcoming projects should be included in the project description of the bid proposal. The wall types permitted at each location should be shown and basic information such as wall length, square footage, etc., described. This is especially important for proprietary walls because these designs must be prepared in sufficient depth to enable reliable pricing by the suppliers during the advertising period.

The successful bidder will be required to indicate the type of preapproved proprietary wall he intends to construct on or before the date of the preconstruction conference. Prior to the beginning of wall construction, the selected wall supplier will be required to submit a detailed design and detailed plans for approval according to [Subsection 105.02](#) of the [Standard Specifications](#) and the contract special provisions.

460.08 Requirements for Supplier-Prepared Design and Plans. The final design to be submitted subsequent to contract award shall include detailed design computations, limits of design responsibility, if any, and all details, dimensions, quantities, and cross sections necessary to construct the wall. The fully detailed plans shall be prepared to ITD standards and shall include, but not be limited to, the following items:

- A plan and elevation sheet or sheets of each wall, containing the following:
 - An elevation view of the wall which shall indicate the elevation at the top of the wall, at all horizontal and vertical break points, and at least every 15 meters (50 feet) along the wall; elevations at the top of leveling pads and footings; the distance along the face of the wall to all steps in the footings and leveling pads; the designation as to the type of panel or module; the length, size, and number of backfill reinforcing elements and the distance along the face of the wall to where changes in length of the backfill reinforcing elements occur; and the location of the original and final ground line.
 - A plan view of the wall which shall indicate the offset from the construction centerline to the face of the wall at all changes in horizontal alignment; the limit of the widest module, or reinforcement and the centerline of any drainage structure or drainage pipe which is behind or passes under or through the wall.
 - Any general notes required for design and construction of the wall.
 - All horizontal and vertical curve data affecting wall construction.
 - A listing of the summary of quantities provided on the elevation sheet of each wall for all items, including incidental items.
 - Cross section showing limits of construction and, in fill sections, limits and extent of select granular backfill material placed above original ground.
 - Limits and extent of reinforced soil volume.
- All details, including reinforcing steel bending details. Bending details shall be in accordance with ITD standards.
- All details for foundations and leveling pads, including details for steps in the footings or leveling pads, as well as allowable and actual maximum bearing pressures.
- All modules and facing elements shall be detailed. The details shall show all dimensions necessary to construct the element, all reinforcing steel in the element, and the location of reinforcement element attachment devices embedded in the facing.
- All details for construction of the wall around drainage facilities, overhead sign footings, and abutment piles or shafts shall be clearly shown.

- All details for connections to traffic barriers, coping, parapets, noise walls, and attached lighting shall be shown.
- The plans shall be prepared and signed by a professional engineer licensed in the state of Idaho.

Eight sets of design drawings and detailed design computations shall be submitted to the Resident Engineer. The computations shall include a detailed explanation of any symbols and computer programs used in design. The Resident Engineer shall retain three sets for district use.

The remaining design drawings and computations will be distributed as follows:

- Two sets to the Design Section (one set will be transmitted to the consultant on consultant design projects)
- One set to the Bridge Design Section
- One set to the Materials Section
- One set to the Construction Section

All designs and construction details will be checked by the Materials and Bridge Design Sections against the preapproved design and procedures for that system. Design and construction details will be checked by all recipients for conformance with the conceptual design constraints and criteria. Results of the reviews and/or approvals will be forwarded to the Materials Section for transmittal to the district. Notification to the contractor will be made by the district.

460.09 Materials Approval. Prior to delivery of any material used in the retaining wall construction, the sources must be accepted in conformance with [Section 106.01](#) of ITD [Standard Specifications](#).

460.10 ITD Responsibility. The following sequence outlines the organizational unit and necessary actions by that unit to select, coordinate, and review designs and monitor construction of earth-retaining structures.

460.10.01 Initial System Approval.

Organization Unit	Responsibility and Action
Materials Section** (Geotechnical Engineer)	Reviews geotechnical and materials aspects of new earth-retaining system supplier submittal. Acts as chairman of earth-retaining system evaluation committee. Transmits committee recommendations to Assistant Chief Engineer (Operations).
Bridge Design Section**	Reviews structural aspects of new earth-retaining system supplier submittal and provides formal comments to the Materials Section.
Design Section	Reviews geometric constraints and constructability of new earth-retaining system supplier submittal and provides formal comments to the Materials Section.
Construction Section	Reviews specifications and construction requirements for new earth-retaining system supplier submittal and provides formal comments to the Materials Section.
Assistant Chief Engineer (Operations)	Reviews and approves committee action. Notifies supplier of system acceptance or rejection.

* Earth-retaining system evaluation committee composed of representatives of Materials, Bridge Design, Design, and Construction Sections. The Geotechnical Engineer acts as chairman.

** Structural and geotechnical system reviews apply to all methods of retaining system selection, alternate bidding, and experimental.

460.10.02 Retaining System Selection.

Organization Unit	Responsibility and Action
District Project Development	Determine need for a retaining structure or system at a specific location on a project.
Design Section (on special Headquarters design projects), Consultant	<div>Need may be determined during preparation of Phase I or Phase II investigations by District Materials or consultant.</div> <p>Request subsurface investigation and retaining system selection recommendations from District Materials (or consultant). Designers should advise District Materials (or consultant) of particular conditions, design constraints, environmental, or aesthetic requirements.</p>
District Materials, Consultant	<p>Perform subsurface investigation. The report should include specific engineering design criteria for recommended retaining system(s) and alternates and supporting data for recommendations.</p> <p>Transmit report along with investigation plat, if applicable, and/or boring logs to the Materials Section for review.</p>
Materials Section	<p>Geotechnical Engineer and Project Development Engineer review investigation report. Approved report is transmitted to Bridge Design and Design Sections and to the district. Reports are transmitted to FHWA by the Materials Section, if needed.</p> <div>Subsurface investigation may be a Phase IV structure foundation investigation (i.e., cast-in-place concrete walls and tied-back walls), but may be a special investigation addendum to or included in Phase II soil investigation.</div>
District, Bridge Design Section, Design Section, Consultant	<p>Based on investigation report, cost estimates, and project constraints or aesthetic considerations, designer selects retaining system alternates to be allowed.</p> <p>If conventional reinforced concrete, steel bin, gabion, or tied-back walls are proposed, design and plans are prepared.</p> <p>For proprietary systems, a conceptual design is prepared in accordance with Sections 460.04 through 460.07 of this procedure.</p>
District, Bridge Design Section, Consultant	<p>Prepare special provisions for contract documents, including "generic" specifications for supplier-designed retaining systems. Transmit special provisions to Materials Section.</p>

Organization Unit	Responsibility and Action
Materials Section (Geotechnical and Project Development Engineer)	Reviews special provisions. Transmits approved special provisions to District, Design Section, and Bridge Design Section.
District, Design, Materials, Bridge Design, and Construction Sections, Consultant	Make final design review of retaining system design, plans or conceptual design, and special provisions. Comments submitted to Design Section.
Design Section	Prepares final contract documents. Makes PS&E review, advertises project, and publishes contract documents.

460.10.03 Post-Award Design and Plan Review. On projects bid on conceptual design, and where proprietary retaining systems are bid as alternates, the contractor shall designate the system to be constructed on or before the date of the preconstruction conference. Contractor submits eight sets of supplier-developed plans and design computations to the Resident Engineer.

Organization Unit	Responsibility and Action
Resident Engineer	Transmits one set of supplier-prepared plans and design computations to District Project Development/Materials and five sets to sections as shown in 460.08 . Retains two sets for review.
District	Makes design review of supplier-prepared plans and design computations and transmits comments to Materials Section.
Design Section	Makes design review and transmits comments to the Materials Section.
Bridge Design Section	Reviews structural aspects of supplier-developed plans in accordance with Section 460.08 , Requirements for Supplier-Prepared Design and Plans. Comments are transmitted to the Materials Section with a copy to the Design Section.
Construction Section	Makes review of supplier-prepared plans and transmits comments to Materials Section.
	FHWA and consultants also transmit their comments to the Materials Section.
Materials Section	Reviews geotechnical considerations of supplier-prepared design and plans in accordance with Section 460.08 , Requirements for Supplier-Prepared Design and Plans. Transmits approval of supplier-prepared plans to the district.
District	Notifies contractor and supplier of approval and/or comments and changes required.
	The review of supplier-prepared plans is intended to be of the same scope as a final design review. If substantial changes, corrections, and/or revisions are needed, resubmittal of plans may be required.

On projects where design is by the Design Section or on consultant-designed projects administered by the Design Section, transmittals may be direct from the Resident Engineer to the Design Section and from the Design Section to the Resident Engineer.

460.10.04 Construction.

<u>Organization Unit</u>	<u>Responsibility and Action</u>
District, Bridge Design Section, Materials Sections	Provide technical assistance to project construction personnel prior to and during retaining wall construction (preconstruction problems and experimental evaluation of new or unusual systems).
Resident Engineer	Provides construction supervision and inspection. Immediately notifies district and Bridge and Materials Sections of construction problems.
Supplier	Provides technical assistance to contractor and ITD during wall construction.